

Sustainability of a water, sanitation and hygiene education project in rural Bangladesh: a 5-year follow-up

B.A. Hoque,¹ T. Juncker,² R.B. Sack,³ M. Ali,⁴ & K.M.A. Aziz⁵

An integrated water supply, sanitation and hygiene (WSH) education intervention project was run by the International Centre for Diarrhoeal Disease Research, Bangladesh, over the period 1983–87. In the intervention area the project provided handpumps, pit latrines, and hygiene education to about 800 households. The control population did not receive any interventions, but had access to the usual government and private WSH facilities. After 1987 no external support was provided to maintain these provisions. A cross-sectional follow-up survey, which was carried out in 1992, involved about 500 randomly selected households from the intervention and control areas.

In 1992 about 82% of the pumps were still in good functional condition and of these, 94% had been functioning well in 1987. Fewer latrines were functional in 1992 (64%) than at the end of 1987 (93%). In the former intervention area about 84% of the adults were using sanitary latrines in 1992 compared with only 7% in the control area. Knowledge related to disease transmission, however, was poor and similar in both areas. People claimed that they used the WSH facilities to improve the quality of their lives. The prevalence of diarrhoeal diseases in the 1992 survey among the control population was about twice that among those in the intervention area.

Introduction

Many studies of the behavioural and health impacts of water, sanitation, and hygiene (WSH) projects have been carried out (1–7). It has been emphasized that health benefits are achieved when WSH provisions are used and practised by the target population (7, 8). Furthermore, it has been stressed that every project should make efforts to become sustainable (9), i.e. that it is able to deliver an appropriate level of benefits for an extended period of time after major donor assistance is terminated. Sustainability is in many ways the ultimate test of development efforts.

In Bangladesh remarkable efforts have been made to provide safe water and sanitation and to improve hygiene practices in rural areas (10). During the 1980s, when the population increased from about 90 million to 110 million, access to safe water increased in rural areas from 37% to 96% (11, 12). However, only 16% of the population used tubewell water for all domestic purposes. Sanitation coverage was only 26% in 1991 in rural areas.^a Bangladesh has yet to reap the health benefits of WSH projects; water-related diseases remain the main causes of the high morbidity and mortality that prevail in the country (12). Rural tubewell projects often face obstacles arising from the abundant and easily available, highly contaminated, surface water (10). Also, recurrent floods damage sanitary latrines (13). As a result, the use of improved WSH provisions will require special efforts to ensure that they continue uninterrupted throughout the year.

We present here our findings on the behavioural and health benefits about 6 years after the implementation of the Mirzapur Handpump Project, a health impact study of WSH interventions. The results should contribute towards a better understanding of the sustainability of WSH projects.

¹ Head, Environmental Health Programme, International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B), GPO Box 128, Dhaka 1000, Bangladesh. Requests for reprints should be sent to this author.

² Visiting Scientist, ICDDR,B, Dhaka, Bangladesh.

³ Professor, Department of International Health, Johns Hopkins University School of Hygiene and Public Health, Baltimore, MD, USA.

⁴ Data Management Supervisor, Environmental Health Programme, ICDDR,B, Dhaka, Bangladesh.

⁵ Senior Scientist, Community Health Division, ICDDR,B, Dhaka, Bangladesh.

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^a The 1991 national survey on states of rural water supply and sanitation for DPHE/UNICEF. Final report, August 1992.

Materials and methods

The project

The Mirzapur Handpump Project was conducted by the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B) and funded by the Canadian International Development Agency (CIDA) through the World Bank/UNDP. Data were collected while the project was being implemented from five villages in the Mirzapur subdistrict over the period 1984–87. The intervention area, which comprised about 880 households, was provided with 148 improved handpumps (Tara handpumps), one twin-pit latrine for almost every household, and extensive hygiene education. The handpumps were supplied and maintained by the project. The latrines were either supplied at no or nominal cost, but the users had to install the superstructures or contribute towards their installation (6, 14). The intervention area also received extensive education on hygiene practices related to the WSH provisions and on transmission and prevention of diarrhoeal diseases. The control area, which consisted of about 750 households, did not receive any input from the WSH project. Before the project began, there were already about 35 handpumps in the intervention area and 42 in the control area. The two areas were similar with respect to most socioeconomic characteristics and baseline levels of diarrhoeal morbidity. About 30% of each area was flooded annually.

Following introduction of the WSH provisions, the water use and defecation practices of the people significantly improved in the intervention area (6). Furthermore, the children in the intervention area experienced 25% fewer episodes of diarrhoea than those in the control area (6, 15).

During the study, local women participated in selecting the installation sites, in the maintenance of the tubewells and latrines (6, 14, 16), and in collecting data for the project (16). These women were identified by the community or participated out of self-interest; they were mostly illiterate and their socioeconomic characteristics were similar to those of the study population as a whole. The women were trained and given responsibilities to collect information on water collection from handpumps (16), to maintain 30 of the 148 installed handpumps (17), and to maintain latrines (14). The women performed satisfactorily and were as efficient as the project workers.

In 1987 the field activities of the project ceased, whereupon all latrines and handpumps were repaired. At the same time, meetings were held to provide local people with general information on the maintenance of the WSH provisions and to involve

them as much as possible in activities to promote transfer of the technology to the community (6).

After the ICDDR,B project activities had ended, a nongovernmental organization implemented a community education programme during 1989–90 in the intervention area (18).

Study method

During 1992 investigators from the Mirzapur Handpump Project carried out a follow-up cross-sectional survey on WSH provisions in the study area. In the study villages a systematic sample was taken by selecting groups of two consecutive households, after skipping a household. Local women, who were supervised by a project supervisor and assisted by two male project workers, were recruited and trained to collect information.

Data were collected through pre-tested questionnaires by interviewing the housewives or women caretakers of the households and recording data on the following: use and functioning conditions of tubewell and latrines; certain hygiene practices; and knowledge about transmission of diarrhoea. Attempts were made to follow similar data collection methods to those that had been used during the initial project. Use of latrines was checked by searching for signs of their use. The functioning condition of tubewells was considered to be adequate if more than 5 litres of water could be pumped in 30 seconds and that of latrines if there was no leak or overflow from the pits and the platforms were stable. Owing to logistic constraints, we were able to collect only point prevalence data on diarrhoea morbidity. Handwash samples were systematically collected from 10% of housewives, based on the assumption that in every household there was a housewife; both hands were tested separately for faecal coliform bacteria. Details of sample collection procedures and of the microbiological techniques used in the study have been reported elsewhere (19).

Data analysis

The data were coded and entered on personal computers. Rigorous checking, including field repetition of about 5% of the check-list information, was carried out. Analyses were performed using SAS software.

Results

Overall, the general characteristics of the population remained similar in the intervention and comparison areas (Table 1).

Table 1: Characteristics of the intervention and control populations, Mirzapur, Bangladesh, 1986 and 1993

Characteristic	Intervention area:		Control area:	
	1986	1993	1986	1993
No. of households	799	617	713	451
No. of people in households	4 856	3 840	4 524	2 852
% of household heads with occupation:				
Farming	44	36	52	56
Skilled labour	8	12	5	5
Other	48	52	43	39
% of adults (>15 years of age) with no education:				
Male	58	67	59	41
Female	83	84	80	72

Water use

The use of tubewell water for major domestic purposes in the intervention area decreased with time (from 88% to 66%) but was still higher than that in the control area (5%) or the national rate (16%) (Table 2). However, the control area households reported significant improvement in the use of tubewell water for cooking purposes, although the reasons for this are unclear. During the pre-intervention period in the intervention area (6), the water-use practices were similar to those in the control area, i.e. surface water was used for most domestic purposes.

In 1987 all the handpumps in the intervention area were working (maintained by the project), compared with 82% in 1993. The pumps were maintained mainly by users, and a local shopkeeper supplied spare parts. Three-quarters of the respondents in the intervention area claimed that the cost of handpump maintenance was shared by the users; the remaining 25% of respondents in this area and all those in the control area claimed that the maintenance costs were borne by the owners or caretakers of the tubewells.

When asked why they used tubewell water rather than surface water, the majority (84%) of respondents stated that the former water was of better quality. Surface water sources such as ponds were plentiful in both the intervention and control areas.

Sanitation

In 1993 a similar proportion of people in the intervention area continued to use the sanitary latrines as had in 1987 (Table 3). This proportion (83%) was far higher than that in the control area (8%) or else-

Table 2: Proportion of households in the intervention and control areas using tubewell water for various domestic purposes, 1987 and 1993

Tubewell use	% of households in intervention area:		% of households in control area:	
	1987 (n = 799)	1993 (n = 607)	1987 (n = 713)	1993 (n = 45)
Drinking	100	99.4	96	96.7
Cooking	94	97.3	52 ^a	86.2
Washing	87 ^b	75.12	8	10.9
Bathing	82 ^b	69.2	11	5.8
All	88 ^a	66.0	8	4.9

^a Highly significant improvement in that area ($P < 0.001$).

^b Highly significant reduction in that area ($P < 0.001$).

where in the country (26%). Also, the defecation habits of the population in the comparison area were slightly better in 1993 than in 1987 but were more or less the same as those elsewhere in Bangladesh.

A total of 98% of the project latrines were maintained and repaired in 1987 and were left in proper functioning condition in the intervention area. In 1993, a total of 64% of these latrines were still in proper functioning condition. Although the performance of the functioning latrines had decreased between 1987 and 1993, it was as high as that of lined pit latrines installed by users in a recent intensive government- and UNICEF-supported sanitation intervention project in Bangladesh.^b

All the latrine owners reported that they had desludged their pits on more than one occasion; about 6% of the families emptied the pits themselves while the rest hired people, at their own cost, to do the job.

Hygiene practices

Although hygiene practices in the intervention households were as poor in 1993 as they had been in 1987, they continued to remain significantly better than among the control population (Table 4).

Bacteriological contamination of individual hands (faecal coliform-colony-forming units per hand (cfu per hand)) of women in the intervention area was significantly lower than that of women in the control area (Table 5).

Knowledge about transmission of diarrhoea

In 1992 knowledge about transmission of diarrhoea was poor and similar in the intervention and control

^b Bilqis A et al. Report of water and sanitation project in three thanas by the Government of Bangladesh. Unpublished report prepared by ICDDR,B.

Table 3: Distribution of reported defecation sites in the intervention and control areas, 1987 and 1993

Type of site	% of households in intervention area: ^a				% of households in control area: ^a			
	1987		1993		1987		1993	
	M	F	M	F	M	F	M	F
Sanitary/project latrine	88	87	83	83	2	3	8	7
Fixed place for defecation	10	11	9	10	71	96	57	61
Indiscriminate sites	2	2	8	7	27	2	35	32

^a M = male; F = female.

Table 4: Observed hygiene practices in the intervention and control areas, 1987 and 1993

Practice	% of households in intervention area:		% of households in control area:	
	1987 (n = 770)	1993 (n = 607)	1987 (n = 705)	1993 (n = 451)
Water containers covered	96 ^a	72	80 ^a	69
Water pitcher near latrine	66 ^a	47 ^b	5	10 ^b
Ash in latrine	62 ^a	36 ^b	1	2
Cleanliness of latrine adequate	73 ^a	57 ^b	2	5

^a $P < 0.001$ (within intervention area during 1987 and 1993).^b $P < 0.001$ (between intervention and control areas in 1993).Table 5: Distribution of faecal coliform-colony-forming units (cfu) on the hands of study women in the intervention and control areas in 1992^a

Geometric mean cfu per hand	Intervention area (n = 79)	Control area (n = 79)
Left hand	78 ^b (22)	232 ^b (60)
Right hand	65 ^c (15.6)	251 ^c (62)

^a All the values have been log-transformed (ref. 23).^b Student's *t* test between intervention and control areas: 7.28; $P < 0.001$; df = 156.^c Student's *t* test between intervention and control areas: 7.36; $P < 0.001$; df = 156.

areas. Hands were mentioned as factors in diarrhoea transmission by 3% and 10% of the respondents in the intervention area and by 2% and 12% in the control area, respectively. However, a significantly higher proportion ($P < 0.001$) of women in the intervention area (12%) than in the control area (4%) mentioned defecation in an open place as a risk behaviour.

Prevalence of diarrhoeal diseases

The point prevalence of diarrhoeal morbidity (diarrhoeal attacks in the previous 24 hours) was significantly lower among the population in the intervention area than that in the control area (Table 6). The relative risk of diarrhoea among over-5-year-

Table 6: Point prevalence of diarrhoeal morbidity in the intervention and control areas in 1993

	Intervention area	Control area
No. of over-5-year-olds	3465	2582
No. of under-5-year-olds	375	270
No. of over-5-year-olds reporting a diarrhoea attack in previous 24 hours ^b	46 (1.3) ^a	77 (3.0)
No. of under-5-year-olds reporting a diarrhoea attack in previous 24 hours ^c	23 (6)	26 (10)

^a Figures in parentheses are percentages.^b Relative risk (RR) for over-5-year-olds = 2.25; $1.56 < RR < 3.23$; Mantel-Haenszel χ^2 test = 20.32; $P < 0.0001$.^c Relative risk (RR) for under-5-year-olds = 1.96; $0.96 < RR < 2.78$; Mantel-Haenszel χ^2 test = 3.28; $P < 0.07$.

olds living in the control area was twice that among children of this age group who lived in the intervention area. The relative risk of 2.25 among under-5-year-olds was also less, but the difference was not statistically significant.

Discussion

The impact of the WSH project was still measurable 6 years after its completion, even though there were readily available surface-water sources and no exter-

nal support to maintain the project's provisions. The community has continued using the improved WSH practices, maintained the facilities, and experienced health benefits in terms of lower diarrhoeal disease morbidity.

It should be pointed out that the objective of the original WSH project was to measure the health impact of the services provided. The concept of community involvement for maintaining the impacts of the project was introduced only on a limited scale during the later stages of the project; and the results could therefore have been even better had community involvement and installation of WSH provision been considered from the outset.

Women's participation, with support from the community (14), contributed towards the sustained impact, since in a previously reported programme with limited women's participation, behavioural impacts were hardly detectable (20). The involvement of women with the support of men and the community probably generated a positive attitude among the whole community towards improving WSH practices.

The good state of maintenance of the WSH provisions and their continued high level of use confirm that the users invested their money in maintaining these provisions after support for the project ended. The majority of people did not revert to their pre-intervention practices of using surface water for major domestic purposes or defecating in unsanitary latrines. The continued availability of spare parts for handpumps in the locality probably also supported their maintenance. It should be pointed out that during the 24-month period of the initial project, about 60% of the latrine pits filled up. Thus, if this rate of filling were maintained, the users would have to have emptied the latrines at their own cost at least three times between the end of the project and the present survey.

The lower level of contamination of the hands of the intervention women also indicates improvements in environmental and hygiene practice. Other studies have shown that with improved WSH provisions, contamination of hands decreases (21). These improved practices indicate that sustained changes in behaviour occurred.

Although the women's understanding about diarrhoeal transmission was not studied in 1987, the data collected in 1992 showed that in general, they made no connection between improved health and WSH practices. A similar lack of comprehension has been reported previously.^c Interestingly, despite the lack of understanding of the connection between

improved health and WSH provisions and practices among the intervention women, they grasped that the use of improved WSH provisions was linked to a better quality of life. It may therefore be easier to conceptualize and accept better living conditions (provided they are affordable) than to understand links between health and WSH conditions.

The findings of the study also reconfirm that better WSH practices are associated with less diarrhoeal disease. Children and adults in the intervention area experienced a lower level of diarrhoea morbidity than the control population. Over the period 1984–87 the cost of the installations and of hygiene education was estimated to be \$US 15.16 per inhabitant; a one-time expense. Over a 10-year period this cost is less than US\$ 2 per inhabitant. Comparison of the number of diarrhoeal attacks averted, behavioural improvements, and other benefits (22) with the initial programme cost indicates that the investment was worthwhile.

Our findings also suggest the appropriateness of certain monitoring indicators for WSH projects. The indicators that we used in the study (e.g. use of WSH provisions and their functioning conditions, specific hygiene practices, and bacteriological contamination of hands) were useful for indicating the sustainability of the project.

Finally, in view of the long-term varied benefits of the WSH project, studies are needed to determine whether it is worthwhile to implement a "crash coverage" of WSH provisions at subsidized rates for the poor and in public places or to suggest that coverage be implemented by users at their own cost. The latter strategy is likely to be achieved over a much longer period, and therefore the health risks will also be more prolonged.

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^c See footnote a, p. 431.

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Résumé

Viabilité d'un projet intégré portant sur l'approvisionnement en eau, l'assainissement et l'éducation en matière d'hygiène dans une zone rurale du Bangladesh: situation au bout de cinq ans

Un projet intégré d'intervention portant sur l'approvisionnement en eau, l'assainissement et l'éducation en matière d'hygiène a été mis en œuvre par l'International Centre for Diarrhoeal Diseases Research, Bangladesh, de 1983 à 1987, dans les régions rurales du *thana* de Mirzapur (à environ 60 km au nord-est de Dhaka). Dans la zone d'intervention, le projet a fourni des pompes à main (en moyenne une pompe pour 33 personnes), des latrines à double fosse (pour la quasi-totalité des ménages), et a assuré une campagne intensive d'éducation en matière d'hygiène à environ 800 ménages. La population témoin (800 ménages) n'a bénéficié d'aucune intervention, mais avait accès aux prestations habituelles des secteurs public et privé en matière d'approvisionnement en eau, d'assainissement et d'hygiène. Une étude transversale de suivi portant sur les deux populations a été réalisée en 1992 afin de comparer les installations d'approvisionnement en eau, les installations sanitaires, leur niveau d'utilisation et les connaissances des habitants sur la transmission des maladies. Cette étude a porté sur environ 500 ménages de la zone d'intervention et 500 ménages de la zone témoin choisis par tirage au sort. Entre 1987 et 1992, aucun soutien extérieur n'a été fourni dans le domaine étudié.

En général, les installations et pratiques concernant l'eau et l'assainissement ont été maintenues dans la zone d'intervention sans aucun soutien extérieur. En 1992, environ 82% des pompes étaient en bon état de marche, contre 94% en 1987. Dans la zone d'intervention, seules 64% des latrines fonctionnaient encore correctement en 1992 pour l'évacuation des selles, contre 93% en 1987, mais cette proportion est bien supérieure à la proportion observée dans la zone témoin (26%) et dans l'ensemble du Bangladesh (7%). En revanche, les connaissances concernant la transmission des maladies étaient faibles aussi bien

dans la zone témoin que dans la zone d'intervention. La prévalence des maladies diarrhéiques lors de l'enquête de 1992 était environ deux fois plus élevée dans la zone témoin que dans la zone d'intervention.

Ces résultats confirment la viabilité à long terme des bénéfices apportés au niveau des comportements et de la santé par un programme d'intervention portant sur l'eau, l'assainissement et l'hygiène. D'autres études devront être réalisées afin de déterminer s'il est préférable de rechercher une couverture accélérée par des installations sanitaires grâce à des stratégies choisies et subventionnées associées à des programmes de mobilisation sociale, ou de se contenter de mettre en œuvre ces derniers programmes.

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